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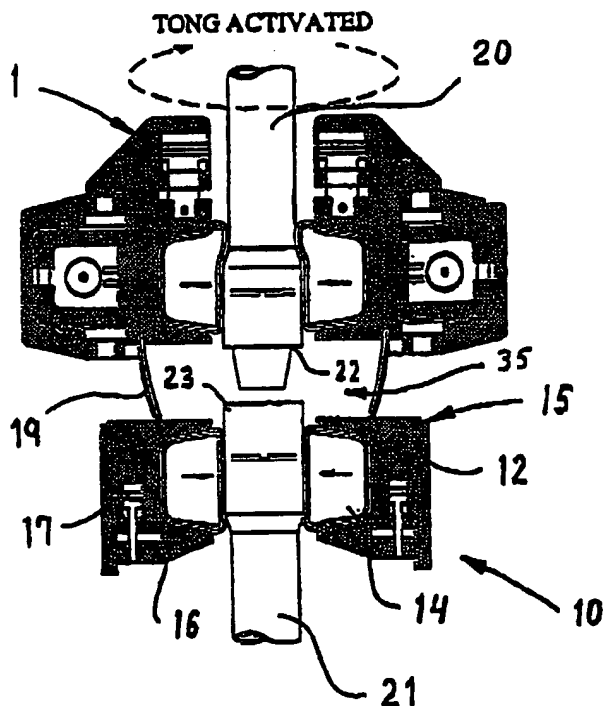
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[Continued on next page]

(54) Title: COMBINED POWER TONG HAVING INTEGRATED MUD SUCTION AND THREAD DOPING APPARATUS



(57) Abstract: A power tong (25) including a dividable spinner and torque tong (1) for spinning in and tightening of a first pipe (20) into a second pipe (21), and an underneath located dividable back up tong (10) for fixedly retaining the second pipe (21) is disclosed. The tongs (1, 10) are axially moveable towards and away from each other. A liquid lock (35) is provided between the spinner and torque tong (1) and the back up tong (10), and a suction for evacuation from the liquid lock (35) the liquid that drains from the pipe (20) during a disconnecting operation between the joints of the pipes (20, 21).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

COMBINED POWER TONG HAVING INTEGRATED MUD SUCTION AND THREAD DOPING APPARATUS

The present invention relates to a power tong comprising a dividable spinner and torque
5 tong for spinning in and making up tubular joints, and an underneath located dividable
backup tong for fixedly retaining the tubular, which tongs are axially movable towards
and away from each other.

A spinner and torque tong of this kind is known from NO 163 973, with same inventor
10 as the present invention.

During drilling of wells for oil and gas, either it be onshore or offshore, drilling pipes
are used in lengths of approx. 9.5 or 14 meters and diameter 90-170mm. During drilling
the wells are secured and consolidated by casings in lengths of approx. 12 meters and
15 diameter 178-510mm. All of these tubulars have threaded joints that are to be made up
with a relatively high torque in order to ensure sealing and that the tubular joints do not
loosen during rotation. This means that one of the main activities during well drilling is
related to make up and break out tubular joints. Totally about 2-4000 such joining
operations per well are involved. For the last 25 years mechanised tools have existed for
20 these operations.

The existing mechanised equipment for joining tubulars during drilling operations are
classified in two categories, power tongs for drill pipes and power tongs for casings.
These are two different tools of which the power tong for drill pipes is permanently
25 installed on drill floor and the casing power tong is assembled each time a casing string
is to be run into the well. By existing technology such equipment has to be individually
constructed; the casings have thin walled joints while drill pipes have thick walled
joints. Substantial manual work is involved for assembling and disassembling the
equipment for casing running operations.

30 In many instances during retrieving operations of a drill string, said string happens to be
filled with drilling mud. The string is disassembled in lengths of about 30m, and by
separating such a length, the entire mud volume thereof drains out and spills on the drill
floor. This is a matter of volume from 125-500 litres. Due to the height of the mud
35 column and the high specific gravity of the mud, the static pressure of the mud at drill

floor level is some times up to approx. 5 bar. Due to the working environment and other practical reasons, this can not be let off on the drill floor and thus a mud skirt that surrounds the tubular joint is mounted (see fig.1). This is both a work demanding and time consuming operation, which in many cases also is related to severe working environment consequences. In the later years, within the Norwegian oilfield sector, mechanically operated mud jackets have been installed.

During running of the drill string into the well, the pipe joints need to be cleaned and lubricated before spinning in the joints. Traditionally this has been a manual operation by use of a bristle. In the later years, however, different types of machines have been developed for this purpose. However, since these machines stand separate from the power tong and are indeed exposed for damages, they have not been very successful. They have also impeded the operation. It is a strong need in the industries for reliable equipment for this operation since it is considered working environmental unacceptable with manual work in the middle of an automated and mechanised sequence.

The traditional power tong for drill pipes constitutes two main units; an upper unit with drive rollers for spinning in the threads as long as this operation runs easy (spinner tong), and a lower unit that makes up the joint with a set torque. This means that a complete working cycle consists of many operations that are controlled in sequence. Previously all of these functions were manually controlled, but in the later years, almost without exception, they are PLS controlled. The mechanical design is basically not suited for automatic sequence control, which in many cases have lead to that the working sequence in automated machines runs slower than manually operated machines.

The present power tong introduces a quite new tong concept that combine spinner tong and torque tong in one unit, integrates equipment that collects and suck off drilling mud and integrates equipment for cleaning and lubrication of the threads. In addition the tong elements are easy replaceable so that casings also can be run with the same machine.

According to the present invention a power tong of the introductory said kind is provided, which power tong is distinguished in that a liquid lock is provided between the spinner and torque tong and the backup tong, and a suction for evacuation from the

liquid lock the liquid that drains from the tubular during a disconnecting operation between the tubular joints.

In one embodiment the liquid lock is defined by one from the spinner and torque tong
5 downwards directed skirt that circumferentially defines the liquid lock and seals against the backup tong.

Preferably the skirt can be made of a flexible material deflecting inwards during axial motion of the torque tong and the backup tong towards each other.

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In a second embodiment the liquid lock can be circumferentially defined by a collapsible boot or bellows.

Conveniently an automatic operable thread doping apparatus may be integrated, which
15 is arranged between the spinner and torque tong and the backup tong, said thread doping apparatus is operable before a spinning in operation between tubular joints are initiated.

Suitably the spinner and torque tong, the backup tong, the liquid lock and the thread
20 doping apparatus can be integrated and arranged in a trolley chassis displaceable on the base floor, said trolley chassis having a vertical column for guiding the spinner and torque tong and the backup tong vertically towards and away from each other.

The tongs can include a locking mechanism keeping the stationary housing together when the tongs are in operation. While making up the torque of the tubular joints, a
25 working cylinder and a pawl making engagement with the driven ring gear may be used.

Other and further objects, features and advantages will appear from the following description of one for the time being preferred embodiment of the invention, which is given for the purpose of description, without thereby being limiting, and given in
30 context with the appended drawings where:

Fig.1 shows schematically a situation during disconnection of drill pipes,

Fig.2 shows schematically an elevation view of one complete power tong according to
35 the invention,

Fig.3 shows schematically from above the power tong according to fig.2,

Fig.4 shows schematically a front view of the power tong according to fig.2,

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Fig.5A and 5B show schematically in longitudinal cross-section and from above respectively, a spinner and torque tong in an inactivated state,

Fig.6A and 6B show schematically the tong according to fig.5A and 5B in an activated
10 state,

Fig.7 shows schematically a longitudinal cross section through the spinner and torque tong, and an underneath located backup tong in position for spinning in tubular joints,

15 Fig.8 shows schematically a longitudinal cross section through the tongs according to fig.7 in position after the spinning in of the tubular joints,

Fig.9 shows schematically the tongs according to fig.5-8 used on a 500mm casing,

20 Fig.10 shows schematically the tongs according to fig.5-8 used on a 300mm casing,

Fig.11 shows schematically a longitudinal cross section through a second embodiment of the liquid lock between the spinner and torque tong and the underneath located backup tong, and a jetting and thread doping apparatus,

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Fig.12 shows the second embodiment according to fig.11 when the spinner and torque tong and the backup tong are displaced towards each other, and

Fig.13 shows schematically from above the backup tong having provided a jetting
30 means and a thread doping apparatus respectively.

Fig.1 shows a situation during drilling of wells for oil and gas, both onshore and offshore. Often drill pipes in lengths of approx. 9.5 or 14 meters and diameter 90-170mm are used. These are in turn assembled to pipe stands 26 consisting of three
35 individual pipes of said length. The pipe stands are hanged off in an elevator 27

depending from a crown block in top of a derrick (not shown). The pipe stands are assembled to the drill string by means of a power tong 25 displaceable arranged on the drill floor towards and away from drill centre. Conversely, during disassembly of the drill string, pipe stands consisting of three individual pipes are disconnected from the drill string. Also here the power tong 25 is used to break out and spinning out the pipe joints.

The complete integrated power tong 25 is shown in entirety in fig.2. It consists of three main units; trolley and chassis 24 having drive means and possibilities for height adjustments, the spinner and torque tong 1 and the backup tong 10. The trolley 24 has wheel sets running on rails that are deployed on drill floor or the base. The trolley 24 is displaceable on the rails towards and away from drill centre, which is defined by the longitudinal axis of the pipe stand 26 in fig.1.

The spinner and torque tong 1 can be elevated and lowered along the vertical column of the trolley 24. Similarly the backup tong 10 can be elevated and lowered along the same vertical column. Between the spinner and torque tong 1 and the backup tong 10, a skirt 19 is provided, which defines a liquid lock 35 intended for collecting drilling mud that remains in the pipe stand 26 when the pipe stand is disconnected and lifted out of the drill string. This is shown in more detail in fig.7 and 8.

Fig.3 shows the power tong 25 from above. The spinner and torque tong 1 and the backup tong can be opened along a partition line D in order to be able to proceed towards and embrace a tubular. In front is a locking mechanism 37 having a locking bar and shutting lock shown. The lock has a built in actuator. The lock actuator has a cam that progress into mechanical engagement with the driven ring gear when this is in position for opening the tong 1. This ensures that the tong 1 does not open up unless the rotatable components are aligned with the openings, i.e. the partition line D. At the rear end of the tong housing is a hydraulic cylinder arranged for opening and closing the tong. A corresponding locking mechanism 38 is also provided on the backup tong 10.

Fig.4 shows the power tong 25 viewed at the front thereof. A pair of hydraulic cylinders 28 is at the upper ends thereof connected to the trolley chassis 24 and at the lower ends thereof to the backup tong 10. The backup tong 10 has several wheel pairs 34 running in guides or rails on the trolley chassis 24. By actuation of the hydraulic cylinders 28, the

backup tong 10 can be elevated or lowered as desired. Correspondingly the spinner and torque tong 1 has several wheel pairs 36 running in vertical guides or rails on the trolley chassis 24. A second pair of hydraulic cylinders 29 are at the lower ends thereof connected to the trolley chassis 24 and at the upper ends thereof connected to the spinner and torque tong 1. The hydraulic cylinders 29 can correspondingly elevate or lower the spinning and torque tong 1 as needed. By spinning in tubular joints the spinner and torque tong 1 approaches the backup tong 10 in concert with the increasing engagement of the threads with each other. And conversely, by spinning out the tubular joints the spinner and torque tong moves away from the backup tong 10 in accordance with the decreasing engagement of the threads with each other.

With reference to fig.5A and fig.5B, a spinner and torque tong 1 is shown in closer detail. The tong 1 has an outer stationary housing 5 and an inner rotatable housing 2. A drive gear 9 is supported in the outer housing 5 and the drive gear 9 is in mesh with teeth of a driven ring gear 3 connected to and supported in the rotatable housing 2. The outer stationary housing 5, the inner rotatable housing 2 and the driven ring gear 3 are dividable, i.e. that they can be opened for proceeding towards a tubular in opened state and subsequently be closed for embracing the tubular. The both housings 5,2 and the driven ring gear 3 have a partition line along which they can be opened. Before opening of the housings 5,2 and the driven ring gear 3, the respective partition lines have to coincide. This means that the inner rotatable housing 2 and the driven ring gear 3 have to be rotated in respect of the outer housing 5 so that the partition line D thereof coincide with the partition line of the outer housing 5.

The inner rotatable housing 2 receives and retains one or more gripping elements 4. The gripping elements 4 are in form of bodies that are both resilient and incompressible. This means that they are not able to change in volume, only in form. The rotatable housing 2 also include a squeeze part 6 that is connected to a hydraulic system that is able to activate hydraulic squeeze cylinders 7 acting directly on the squeeze part 6. The gripping elements 4 are axially and radially restricted outwards by the housing 2 proper and the squeeze part 6 such that deformation can occur in a substantially radially inward direction only. By activation of the hydraulic system the squeeze cylinders 7 are applied pressure that urge the squeeze part 6 axially against the gripping elements 4 having the housing 2 as an abutment. Thus the incompressible bodies have one way to expand only, namely radially inward toward the tubular. This inward facing surface has a

friction face 4F. Also the outwards facing surface may have custom formed friction face, possibly lugs or teeth that mesh with corresponding lugs or teeth in the housing 2.

The gripping elements 4 are described in more detail in co-pending international patent application PCT/NO99/00400 with title: "Device for frictional engagement with tubular goods".

Fig.6A and 6B show the spinner and torque tong 1 in a conceived activated state (without the tubular) and illustrate the deformation that happens in the gripping elements 4. Between the driven ring gear 3 and the rotatable housing 2, two cylinders, pumping cylinders 8, are arranged diametrically opposite each other. The pumping cylinders 8 are in one end thereof supported in the driven ring gear 3 and in opposite end supported in the rotatable housing 2. The pumping cylinders 8 provide the connection between the driven ring gear 3 and the rotatable housing 2. However, a rotational motion of freedom is present between the driven ring gear 3 and the rotatable housing 2. This motion of freedom is restricted by the stroke of the pumping cylinders 8. The driven ring gear 3 is rotated by means of the drive gear 9 that is driven by a hydraulic motor (not shown).

In the rotatable housing 2 are four cylinders 7 provided, called squeeze cylinders, which are able to urge down the squeeze part 6, which in turn exert pressure against the gripping elements 4. The four squeeze cylinders 7 are in hydraulic communication with the pumping cylinders 8 in a closed hydraulic system.

By rotating the drive gear 9 and thus the driven ring gear 3, the pumping cylinders 8 are compressed. The friction between the squeeze part 6 and the housing 2 is higher than that between the driven ring gear 3 and the housing 2 so that the pumping cylinders 8 are completely compressed before the squeeze part 6 is dragged along in the rotation. This entails that the squeeze cylinders 7 are applied pressures in accordance with the compression of the pumping cylinders 8. This is illustrated in fig.6A and 6B. The motion of the squeeze cylinders 7 leads in turn to that the gripping elements 4 are compressed and receive a smaller inner diameter resulting in a squeeze force against the tubular.

Fig.7 shows a spinner and torque tong 1 that supports a drill pipe 20 ready for spinning into a socket end of a second drill pipe 21. The second drill pipe is retained by a device for gripping and fixing a tubular, in the following called a back up tong 10. The shown back up tong 10 constitutes the simplest design taking advantage of the invention. The back up tong 10 comprises a stationary divided housing 15 having a main part 12 and a squeeze part 16, which are, in respect of the pipe 21, axially moveable towards each other. In the illustrated embodiment, it is the squeeze part 16 that is displaceable by means of a hydraulic cylinder 17 and the main part 12 acts as abutment. The gripping elements 14 are, by activation of the squeeze part 16, compressed and squeezed radially inwards against the drill pipe 21. The friction face 14F of the gripping elements 14 makes direct engagement with the drill pipe 21. The back up tong 10 including all components can be opened along a partition line, in order to proceed toward a pipe and subsequently be closed for embracing the drill pipe 21.

Fig.8 shows a situation where the spinner and torque tong 1 has spinned the pin end of the drill pipe 20 into the socket end of the drill pipe 21. During such a spinning in operation, the tongs 1,10 are axially moved towards each other; normally the spinner and torque tong 1 towards the back up tong 10. The squeeze cylinders 17 are activated by an ordinary hydraulic system that supplies pressure to the piston of the squeeze cylinders 17.

Subsequent to that the threaded joint is spinned in, a working cylinder for making up the set torque in the tubular joints is actuated. The lower tubular 21 is still fixedly retained by the backup tong 10. The cylinder displaces a toothed pawl into engagement with the teeth of the driven ring gear 3 and turns the gear 3, the housing 2, the squeeze part 6 and the retained pipe 20 until the predetermined make up torque in the tubular joint is obtained.

A similar cylinder and pawl are provided on opposite side of the tong housing 2 for breaking out the torqued tubular joints. The lower tubular 21 is fixedly retained by the backup tong 10. The entire squeeze means can be reversed by resetting valves between the pump cylinders 8 and squeeze cylinders 7.

Fig.7 and 8 also show the mud skirt 19 in closer detail. The mud skirt 19 seals between the two tongs 1,10. By the fact that this tong design embraces the tubular joint

completely, a sealed off chamber, or liquid lock 35, can be obtained between the two tongs 1,10 by means of the skirt 19. This liquid lock 35 is applied with vacuum so that the drilling mud is sucked off effectively in those cases this is required. An apparatus 11 for high pressure jetting and lubrication of the threaded sections is also provided in this liquid lock 35. Reference is given to fig.11-13 for a more detailed description of this apparatus 11.

Fig.8 shows a situation where the tongs 1,10 are completely mated and the mud skirt 19 deflects inwards. Alternatives to the skirt 19 are a boot or bellows that are able to perform the same function. The material is that a sealed off enclosure in form of a liquid lock 35 that retains the mud until it is evacuated is provided.

Fig.9 shows another situation in which a variant of the spinner and torque tong 1' is used on a 20" casing 30 having a threaded pin end 32 that is to be spinned into a threaded socket end 33 of a corresponding casing 31. The casing 31 is fixed by a variant of the backup tong 10'. The spinner and torque tong 1' has a configuration and a moment of force that is in particular adapted to the make up torques applicable for casings.

Fig.10 shows still another situation in which a variant of the spinner and torque tong 1'' is used on a 13 3/8" casing 40 having a threaded pin end 42 that is to be spinned into a threaded socket end 43 of a corresponding casing 41. The casing 41 is fixed by another variant of the back up tong 10''. The spinner and torque tong 1'' has a configuration and a moment of force that is in particular adapted to the make up torques applicable for this smaller casing 40.

Fig.11 shows a second embodiment of the liquid lock 35' and the mud skirt 19' provided between the spinner and torque tong 1 and the backup tong 10. The jetting and thread doping apparatus 11 is also shown in a way it can be arranged on the backup tong 10. As illustrated, the mud skirt 19' is now secured to the outer stationary spinner and torque tong housing 5 and to the outer housing 15 of the backup tong 10. For evacuation of the liquid that is retained in the lock 35', an outlet 13 and a chute 18 are provided in the housing 15. The chute 18 leads the liquid towards the outlet 13. A vacuum hose can be mounted to the outlet 13 for enclosed evacuation of the liquid.

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Fig.12 shows how the mud skirt 19' is compressed and folds together in the same way as a boot or bellows.

The placement of the jetting and thread doping apparatus 11 is shown in fig.13. In particular is a jetting means 11A in form of a nozzle for cleaning of the threads on a tubular end shown. This operation takes place while the mud lock is intact and the jetting liquid can be evacuated as described above. A thread doping apparatus 11B in form of a lubrication nozzle for applying fresh lubricant onto the threads of the tubular ends before the tubulars are spinned in is also illustrated. The jetting and thread doping apparatus is adapted both for manual and automatic operation of the jetting means 11A and the lubrication nozzle 11B and can be operated independently of each other. If necessary, several jetting means 11A and lubrication nozzles 11B can be deployed at convenient locations of the backup tong 10, optionally on the spinner and torque tong 1.

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P a t e n t c l a i m s

1.

A power tong (25) comprising a dividable spinner and torque tong (1) for spinning in
5 and making up a first tubular (20) to a second tubular (21), and an underneath located
dividable backup tong (10) for fixedly retaining the second tubular (21), which tongs
(1,10) are axially movable towards and away from each other, c h a r a c -
t e r i s e d i n that a liquid lock (35) is provided between the spinner and
torque tong (1) and the backup tong (10), and a suction (13) for evacuation from the
10 liquid lock (35) the liquid that drains from the tubular (20) during a disconnecting
operation between the joints of the tubulars (20,21).

2.

A power tong according to claim 1, c h a r a c t e r i s e d i n that
15 the liquid lock (35) is defined by one from the spinner and torque tong (1) downwards
directed skirt (19) that circumferentially defines the liquid lock (35) and seals against
the backup tong (10).

3.

A power tong according to claim 2, c h a r a c t e r i s e d i n that
20 the skirt (19) is be made of a flexible material deflecting inwards during axial motion of
the spinner and torque tong (1) and the backup tong (10) towards each other.

4.

A power tong according to claim 1, c h a r a c t e r i s e d i n that
25 the liquid lock (35) is circumferentially defined by a collapsible boot or bellows.

5.

A power tong according to any of the claims 1-4, c h a r a c t e r i -
30 s e d i n that a jetting and thread doping apparatus (11) is arranged between the
spinner and torque tong (1) and the backup tong (10), said jetting and thread doping
apparatus (11) is operable before a spinning in operation between tubular joints are
initiated.

6.

A power tong according to any of the claims 1-5, c h a r a c t e r i -
s e d i n that the spinner and torque tong (1), the backup tong (10), the liquid
lock (35) and the jetting and thread doping apparatus (11) is integrated and arranged in a
5 trolley chassis (24) displaceable on the base, said trolley chassis (24) having a vertical
column for guiding the spinner and torque tong (1) and the backup tong (10) vertically
towards and away from each other.

7.

10 A power tong according to any of the claims 1-6, c h a r a c t e r i -
s e d i n that the spinner and torque tong (1) and the backup tong (10)
comprises a locking mechanism keeping the stationary housing (2) together when the
tongs (1,10) are in operation.

15 8.

A power tong according to any of the claims 1-7, c h a r a c t e r i -
s e d i n that the make up torque is set by a working cylinder and pawl making
engagement with the driven ring gear (3).

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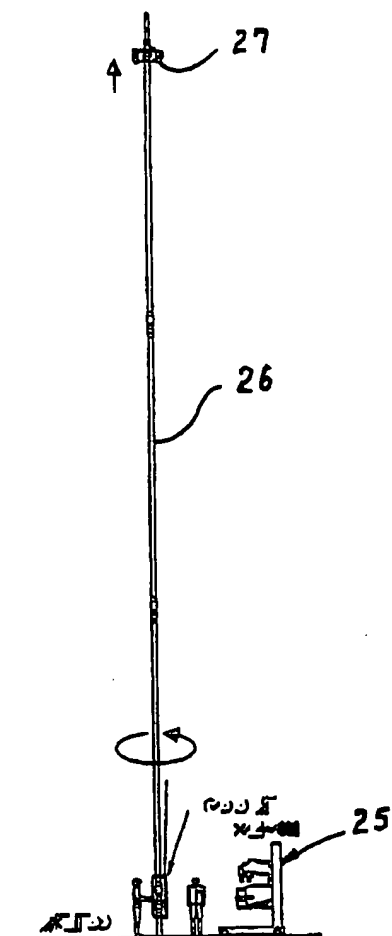


Fig. 1.

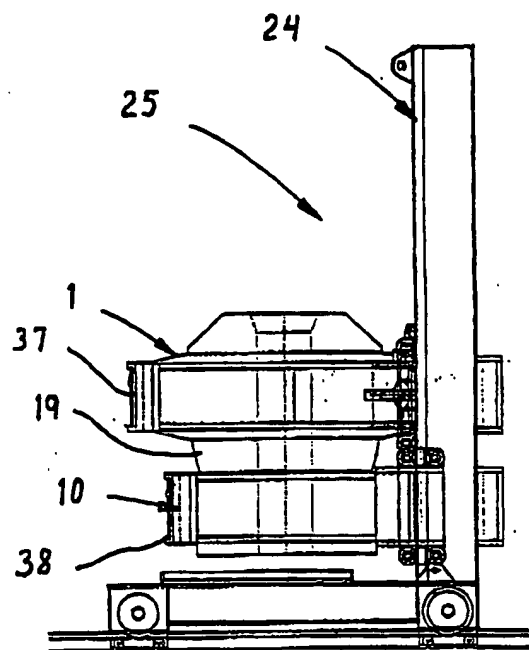


Fig. 2.

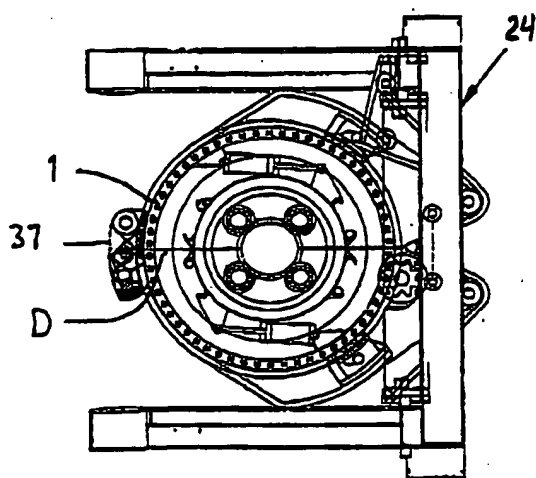


Fig. 3.

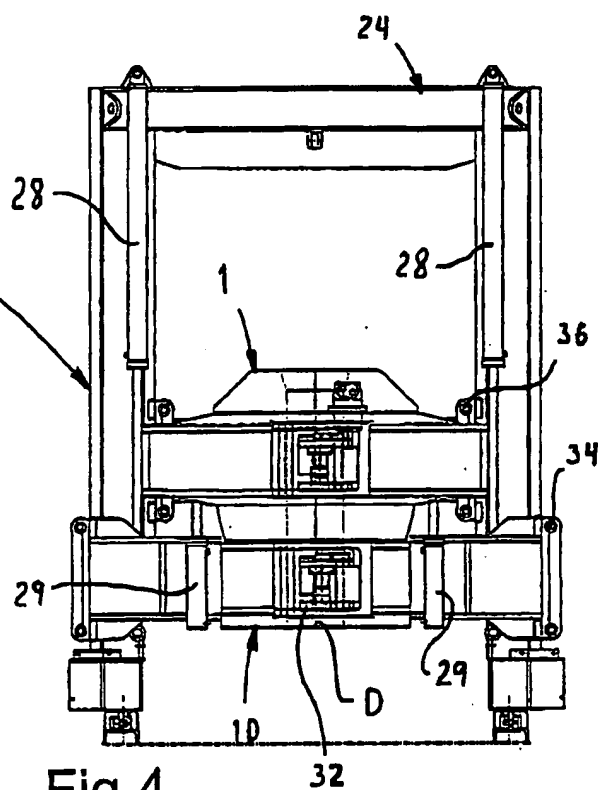


Fig. 4.

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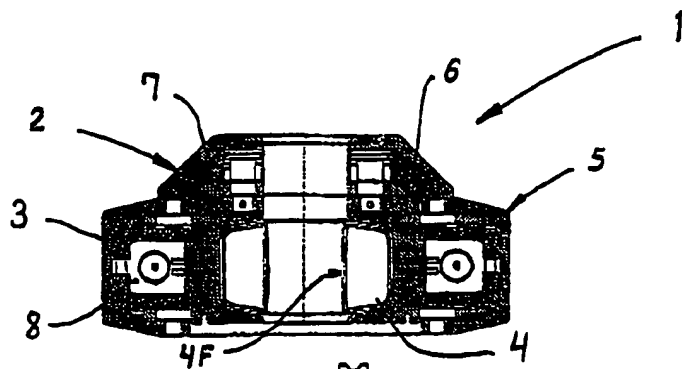


Fig.5A.

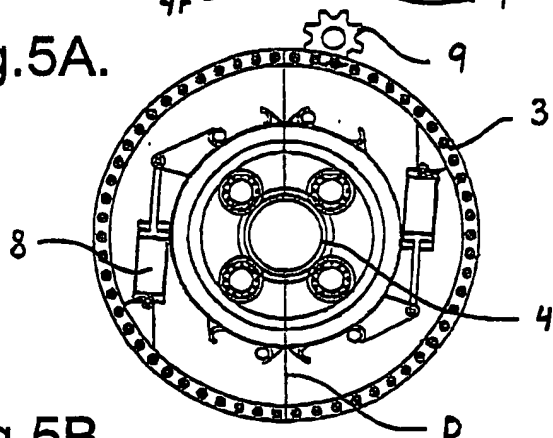


Fig.5B

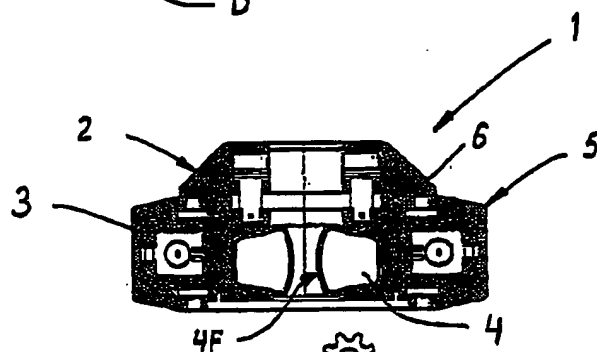


Fig.6A.

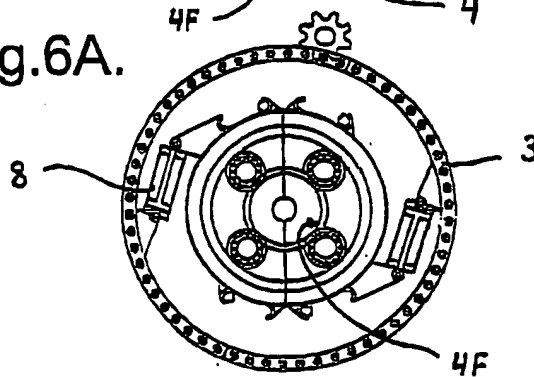


Fig.6B.

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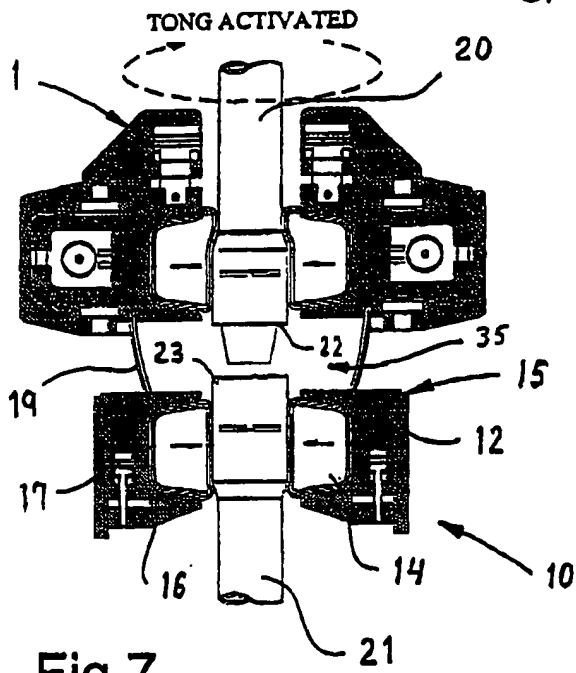


Fig. 7.

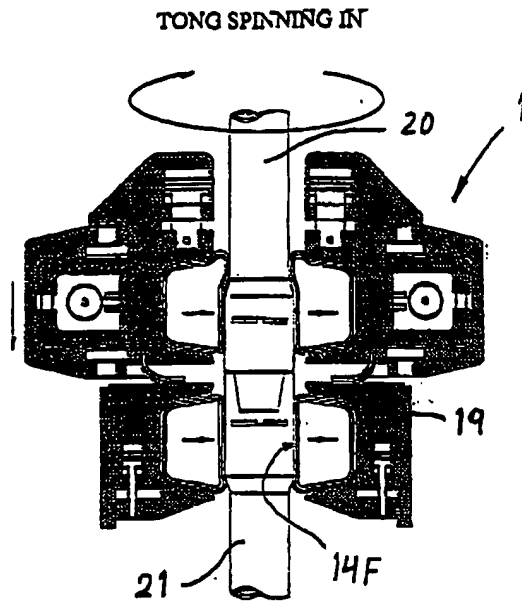


Fig. 8.

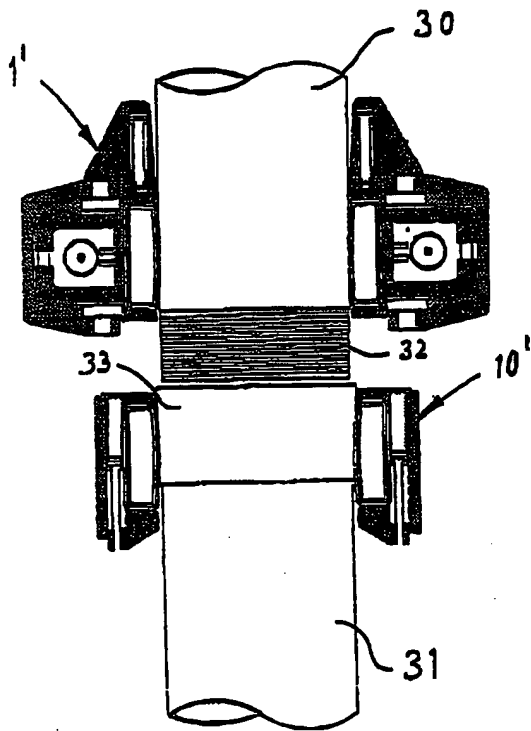


Fig. 9.

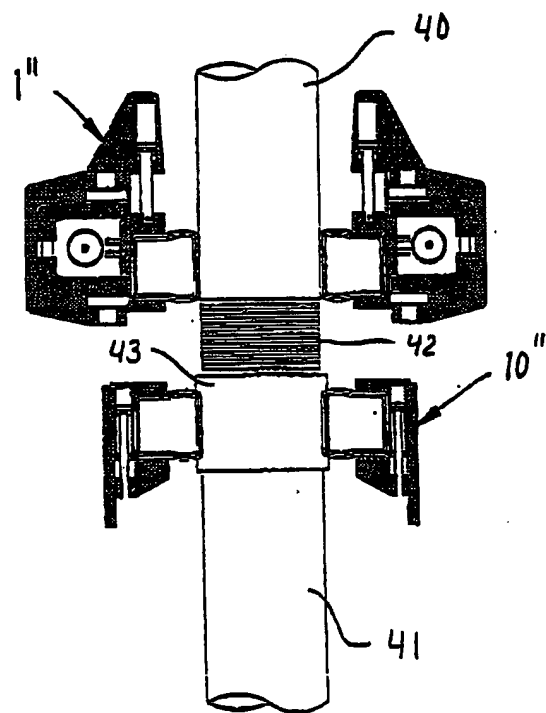


Fig. 10.

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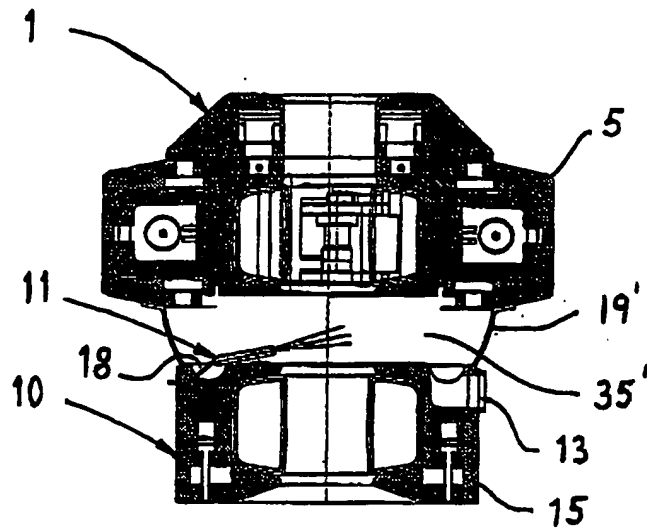


Fig.11.

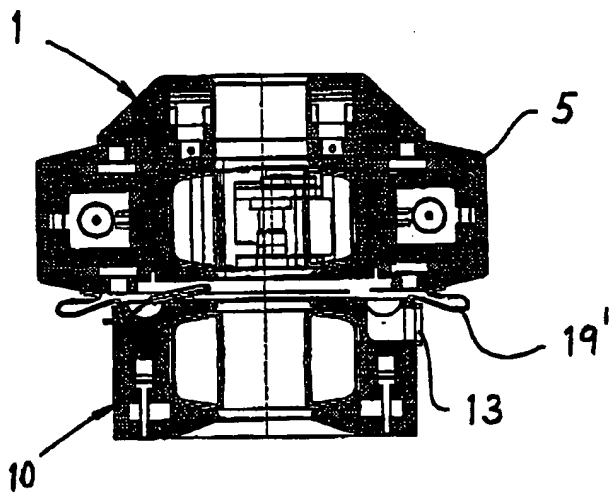


Fig.12.

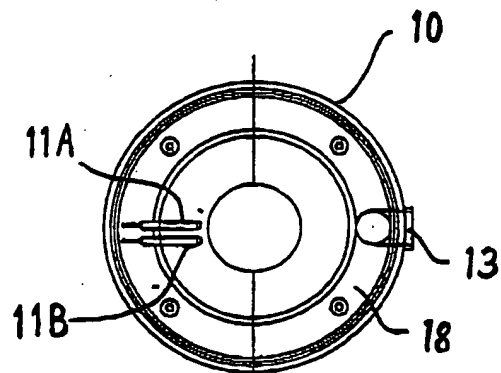


Fig.13.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 99/00399

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 19/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4643259 A (ZERINGUE, JR), 17 February 1987 (17.02.87), column 6, line 36 - column 7, line 30, figure 1 --	1
X	US 4162704 A (GUNTHER), 31 July 1979 (31.07.79), column 4, line 1 - line 45, figure 1 --	1
A	US 4355826 A (VON BRAUN), 26 October 1982 (26.10.82) --	1-8
A	US 4450905 A (CRAIN), 29 May 1984 (29.05.84) --	1-8

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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Date of the actual completion of the international search

14 Sept. 2000

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 99/00399

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5295536 A (BODE), 22 March 1994 (22.03.94) -----	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/06/00

International application No.

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US	4643259	A	17/02/87	NONE	
US	4162704	A	31/07/79	NONE	
US	4355826	A	26/10/82	NONE	
US	4450905	A	29/05/84	NONE	
US	5295536	A	22/03/94	NONE	